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Students' psychological Characteristics as Factor of Effective Acquisition of Visual Information In E-learning

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Abstract

This article is motivated by the fact that teachers choose a form of visualization basing on their subjective views on the ways to make multimedia presentation or on the existing standards, not taking into account that effective acquisition of visual information equally depends on psychological characteristics of students. The main purpose of this research is to identify psychological characteristics assisting students' effective acquisition of information presented in different visual forms (text, charts, comics) in e-learning. The methods used included, firstly, experiment in an educational setting, secondly, control tasks created on the basis of Bloom's taxonomy, and, finally, psychodiagnostic techniques studying: cognitive and metacognitive skills, learning motivation, and self-organization. The findings allow us to identify which forms of electronic visual information are more suitable for students of certain psychological types. These results can help teachers to create conditions for students' more effective absorption of visual information by taking into account their psychological characteristics.

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Keywords: e-learning; acquisition of visual information; metacognitive skills; learning motivation; students' self-organization

1. Introduction

It is common knowledge that in an educational process the combination of students' individual characteristics and pedagogical conditions of learning are to be considered. Different tools for information visualization are widespread

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among teachers. However, choosing the form of visualization to present information on their subjects, teachers frequently rely on their subjective opinion about the effects of the multimedia presentation format (Bajgonakova G.A., Temerbekova A.A., 2013). Apart from that, they can use practices recommended by researchers of multimedia teaching tools, overlooking the fact that effective acquisition of visual information also depends on students' psychological make-up.

There are a number of studies describing students' individual psychological features which facilitate or hinder effective acquisition of information – psychological factors affecting learning. Il'yasov I. (2003) divides such psychological factors into two groups: cognitive factors (perception, memory, imagination, thinking, attention) and factors of personality (motivation, volition, emotions, self-assessment). In his study, Lejtes N. (1971) defines the following psychological components of information acquisition – students' positive attitude to education, their processes of perception, thinking, memorizing information. Applying V. Myasishchev's theory of personality, we suggest that the degree to which students absorb new information depends on the combination of students' motivation, cognitive and behavioral features (V. Myasishchev, 1995).

All these psychological characteristics could have a specific manifestation in an e-learning process. E-learning is generally understood as learning with the application of all kinds of electronic tools (for example: multimedia presentations, computers, interactive whiteboard, smart-phones, etc.) (Anderson J. 2005; Henry L. Steen., 2008). Information technologies in conjunction with face-to-face teaching are considered to be one of the means of e-learning (Guri-Rosenblit S., 2005).

Nowadays methodologists recommend the use of computers and multimedia presentations in class to improve students' retention of information by means of presenting it in the visual form. There is controversial evidence of pedagogical and psychological benefits resulting from the combination of these technological tools. For example, some researchers have come to the conclusion that a PowerPoint presentation created by a teacher for her lesson can «appeal to a number of different learning styles» (Masoud Hashemi, Masoud Azizinezhad, Masoumeh Farokhi, 2011, p.560), increases students' motivation and their engagement in the learning process (Stepp-Greany, J., 2002; Fateme Samiei Lari, 2014), enhances learners' learning achievement and learning satisfaction (Fang-O Kuo, Pao-Ta Yu, Wei-Hung Hsiao, 2015). However, Nouri H. and Shahid A. (2005) found that using PowerPoint presentations did not always help to memorize information and improve the results of learning.

The quality and degree of assimilation of information may be different depending on the form of visualization and students' psychological characteristics. Casteleyn et al. (2011) came to the conclusion that learners preferred e-lecture with graphic organizers to linguistic representations. Similar results were obtained by Johnson and Christensen (2011) in their research. This leads us to the idea that it is necessary to consider the connection between students' psychological features and the form of visual information in the learning process.

The purpose of this research was to identify students' psychological characteristics providing for effective acquisition of information presented via different visual forms (text, charts, comics) in e-learning.

Research Question: How do students' psychological characteristics influence effective assimilation of visual information?

2. Research Methods

2.1. Participants: The initial sample consisted of 166 students in the 3rd, 4th and 5th year at the Faculty of Applied Mathematics and Control Processes (n=76 female and 90 male students, aged between 19 and 23, the mean age being 21.06 years) and 111 students in the 2nd year at the Faculty of Biology (n=80 female and 31 male students, aged between 18 and 25, the mean age being 18.9 years). All of the participants were studying at St. Petersburg State University.

2.2. Research Methods and Instruments:

1. To conduct the experiment, we created multimedia presentations of information in three forms – «text», «charts», «comics» - on three subjects «Abilities», «Temperament» and «Character». These presentations were used by a teacher routinely conducting a class. Presentations were designed in a single style - black and white – to avoid the influence of color on the students' perception.

2. Control tasks were created on the basis of Bloom's taxonomy (Bloom & Krathwohl, 1956) in order to identify the degree of acquisition of visual information. Tests were developed for each subject taught («Abilities»,

«Temperament» and «Character»). There were 6 tasks in the test - one for each learning objective (knowledge, comprehension, application, analysis, synthesis and evaluation of the received information). Every response on the task was evaluated on a five-point scale ranging from 1 (no response, or it is not correct) to 5 (the task done correctly).

3. To identify students' psychological characteristics the following psychodiagnostic techniques were chosen and used in a number of questionnaires:

- students' cognitive and metacognitive skills: «Thinking Styles» (R. Harrison, R. Bremson), «Learning Styles» (Canfield), «State Metacognitive Inventory» (Harold F.O'Neil, Jamal Abedi); «Ideal computer» (Holodnaya M.);
- students' learning motivation with the inventory "Motivation of learning" (A. Rean and V. Yakunin, N.Badmayeva's modification);
- students' self-organization with the inventory «Diagnostics of self-organization features » (A.D.Ishkov).

2.3. Procedure: The first stage of the study comprised lectures with created multimedia presentations on the subject of «Psychology» at the Faculty of Applied Mathematics and Control Processes and Faculty of Biology. In each faculty, the students were divided into three groups, each of them given three lectures with multimedia presentations in different forms: the subject «Abilities» was studied in the *first* group via a presentation in **text**, in the *second* group via a presentation in **comics**, in the *third* group via a presentation in **charts**; the subject «Temperament» was studied in the *first* group via a presentation in **charts**, in the *second* group via a presentation in **text**, in the *third* group via a presentation in **comics**; the subject «Character» was studied in the *first* group via a presentation in **comics**, in the *second* group via a presentation in **charts**, in the *third* group via a presentation in **text**. Thus, all the three groups of students learnt information by means of multimedia presentations in forms of text, charts and comics.

To estimate the degree to which the students assimilated the new information, control tasks created on the basis of Bloom's taxonomy, were used after the students had attended each lecture. After the calculation of the test score, we received the estimates separately for tasks completed by the students after studying subjects in the form of text, charts and comics.

Then, at each faculty, the participants were divided into three groups – those with high, medium and low degrees of acquisition of information - based on their results of control tasks after studying the subjects presented in different forms. Psychological characteristics of those students who demonstrated the highest and lowest degrees of acquisition of information for each visual form were included in the further analysis. The characteristics of the groups are presented in Table 1.

Table 1. Number of students with high and low degrees of acquisition of information studying via text, charts and comics

Form of visual information	Number of students with high degree of information absorption (group A)	Number of students with low degree of information absorption (group B)
Faculty of Applied Mathematics and Control Processes (group C)		
Text	18	24
Chart	32	18
Comics	36	23
Faculty of Biology (group D)		
Text	27	14
Chart	19	14
Comics	28	19

At the final stage of the study, in order to identify the students' psychological characteristics, the participants were asked to do psychodiagnostic tests. Comparisons between the groups with the high degree and between the groups with the low degree of acquisition of information were made using regression analysis.

Data management and analysis were performed using SPSS 20.0.

3. Findings

The hypothesis of the study is the following: there are certain psychological characteristics which influence students' effective acquisition of visual information presented via different visual forms (text, charts, comics) in e-learning.

To reveal the psychological variables which have greater impact on acquisition of visual information, we used multiple regression analysis (method stepwise). Independent variables are characteristics measured through the application of psychodiagnostic techniques, the dependent variable being the degree of information assimilation.

The results of our analysis are illustrated in Table 2 (model summary), Table 3 (for the Faculty of Applied Mathematics and Control Processes) and Table 4 (for the Faculty of Biology).

Table 2. Model summary (regression analysis)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Faculty of Applied Mathematics and Control Processes				
Comics — high degree	,818	,669	,599	,722
Comics — low degree	,636	,405	,357	2,105
Charts — high degree	,729	,531	,462	,630
Charts — low degree	,660	,436	,400	2,537
Text — high degree	,355	,126	,100	1,461
Text — low degree	,461	,212	,182	1,504
Faculty of Biology				
Comics — high degree	,999	,998	,996	,070
Comics — low degree	,589	,347	,282	2,058
Charts — high degree	,991	,982	,968	,188
Charts — low degree	,813	,661	,599	1,079
Text — high degree	,699	,488	,410	,699
Text — low degree	-	-	-	-

Note: *Multiple correlation coefficient* (R) is a measure of the linear connection of one variable with many other. It should be from 0 (no connection) to 1 (strict linear connection). *Coefficient of multiple determination* (R-Square) is the part of variance of dependent variable which is determined by an independent variable (Byuyul' A., Cefel' P., 2005).

Table 3. Results of regression analysis for students' groups with high degree and low degree of information acquisition (Faculty of Applied Mathematics and Control Processes)

		Unstandardized Coefficients		Standardized Coefficients		
Model	Variables	B	Std. Error	Beta	t	Sig.
7	Comics — high degree					
	(Constant)	24,242	1,223		19,826	,000
	Peer (to work in student teams)	-,030	,007	-,473	-4,373	,000

	Self-control	,327	,070	,514	4,711	,000
	Cognitive strategy (metacognition)	,323	,080	,462	4,058	,000
	Categorial questions (focusing on cause-effect relations between objects or events)	,249	,081	,321	3,081	,004
	Students' average or satisfactory predicted level of performance	,014	,005	,310	2,770	,009
	Cognitive motives for learning	-,656	,250	-,298	-2,630	,013
	Competition (desire to compete with others)	-,013	,007	-,241	-1,928	,062
2	Comics — low degree					
	(Constant)	34,330	4,093		8,388	,000
	Realist Thinkers (Thinking style)	-,257	,066	-,615	-3,878	,001
	Goal setting	-,039	,017	-,358	-2,255	,033
4	Charts — high degree					
	(Constant)	25,047	,915		27,374	,000
	Listening (hearing lectures)	,027	,007	,604	3,964	,000
	Qualitative method (work with words or language)	,014	,005	,383	2,866	,008
	Instructor (mutual understanding with teacher)	-,021	,008	-,430	-2,650	,013
	Professional motives of learning	,498	,187	,401	2,664	,013
1	Charts — low degree					
	(Constant)	17,095	,751		22,771	,000
	People (desire to work with people in learning process)	-,095	,027	-,660	-3,515	,003
1	Text — high degree					
	(Constant)	30,128	1,955		15,412	,000
	Synthesists (Thinking style)	-,091	,041	-,355	-2,214	,034
1	Text — low degree					
	(Constant)	17,240	,428		40,281	,000
	Students' below average or unsatisfactory predicted level of performance	-,025	,010	-,461	-2,648	,014

Table 4. Results of regression analysis for students' groups with high degree and low degree of acquisition of information (Faculty of Biology)

		Unstandardized Coefficients		Standardized Coefficients		
Model	Variables	B	Std. Error	Beta	t	Sig.
9	Comics — high degree					
	(Constant)	24,317	,405		59,972	,000
	Students' average or good predicted level of performance	,023	,001	,529	26,389	,000
	Iconic (viewing pictures in learning)	-,028	,001	-,736	-33,503	,000
	Situation analysis	-,315	,020	-,477	-15,833	,000
	Status as motive for learning	-,351	,028	-,353	-12,659	,000

	Idealists (Thinking style)	,098	,006	,442	17,426	,000
	Competition (desire to compete with others)	,011	,001	,246	12,535	,000
	Students' average or satisfactory predicted level of performance	-,004	,001	-,128	-5,745	,001
	Social motive for learning	,219	,041	,170	5,412	,002
	Instructor (mutual understanding with teacher)	-,006	,001	-,135	-4,901	,003
1	Comics — low degree					
	(Constant)	15,060	1,980		7,607	,000
	Status as a motive for learning	2,091	,906	,589	2,307	,044
4	Charts — high degree					
	(Constant)	26,972	,427		63,205	,000
	Will power	-,440	,041	-,841	-10,644	,000
	Analyst Thinkers (Thinking style)	,103	,013	,900	7,777	,001
	Students' below average or unsatisfactory predicted level of performance	-,011	,002	-,423	-6,698	,001
	Self-monitoring (metacognition)	-,152	,044	-,412	-3,435	,019
2	Charts — low degree					
	(Constant)	14,499	2,298		6,311	,000
	Analyst Thinkers (Thinking style)	,163	,037	,828	4,436	,001
	Planning (metacognition)	-,389	,142	-,510	-2,734	,019
2	Text — high degree					
	(Constant)	31,036	,866		35,848	,000
	Competition (desire to compete with others)	-,037	,011	-,761	-3,444	,004
	Categorial questions (focusing on cause-effect relations between objects or events)	-,311	,143	-,481	-2,179	,048
	Text — low degree					
	No variables were entered into the equation					

All the variables presented in the tables significantly influence the degree of acquisition of information ($p \leq 0.05$, $p \leq 0.01$ and $p \leq 0.001$). *Beta-coefficient* indicates a correlation coefficient of the dependent variable with the independent variable. The higher the value of this coefficient, the stronger the impact of the independent variable on the dependent one. For instance, the impact of the analytical thinking style on the low degree of acquisition of visual information in the form of charts is stronger (Beta=0,82) than the influence of planning abilities (Beta= - 0,51). The negative value (-0,51) means that there is an inverse correlation between the dependent and the independent variables: the higher the students' abilities in planning to achieve the goal, the lower the degree of acquisition of visual information in the form of charts.

According to Table 3, the **high degree** of students' acquiring information in the form of **comics** is positively determined by their self-control, cognitive strategy in monitoring the intellectual activity, the tendency to ask categorial questions (focusing on cause-effect relations between objects or events). However, the urge to compete with others (competition) and the desire to work in student teams (peer) demonstrate some negative influence. For students at the Faculty of Biology (Table 4) such characteristics as their average or good predicted level of performance, idealistic thinking style, the social motive for learning, and the urge to compete with others (competition) positively influence the **high degree** of acquisition of information in the form of **comics;** negative influence is exerted by viewing images in the learning process (iconic), the ability to conduct situation analysis, the importance of status as a motive for learning, and others.

The **high degree** of acquisition of information presented in the form of **charts** (for group AC) is positively determined by attending to lectures (listening), work with words or language (qualitative method), and professional motives for learning, however, not by rapport or mutual understanding with the teacher (because there is negative meaning of the variable «instructor»). On the other hand, the students at the Faculty of Biology demonstrated the positive impact of the analytical thinking style and the negative impact of will power, unsatisfactory predicted level of performance and self-monitoring (metacognition) on the **high degree** of assimilating information in the form of **charts.**

Students having the synthetic thinking style in group AC demonstrated negative results while processing the information in the form of **text**; the urge to compete with others (competition) and the tendency to ask categorial questions also reduce the degree of acquisition of **textual** information in the form of **text** (group AD).

There are other results for students with the **low degree** of information absorption.

Students having the realistic thinking style with ability to goal setting (group BC) can more effectively assimilate information in the form of **comics.** For students at the Faculty of Biology (Table 4) the desire to have a high position in their student group (status as a motive for learning) reduces the degree of acquisition of illustrated information.

For students at the Faculty of Applied Mathematics and Control Processes the **low degree** of acquisition of information in the form of **charts** is determined by the negative influence of using such learning method as work with people (interviewing, counseling, helping) in the process of studying new information. Students possessing the analytical thinking style from group BD demonstrated the **low degree** of acquisition of information in the form of **charts.** However, planning learning actions (metacognition) by students can improve it.

Students' below average or unsatisfactory predicted level of performance can increase the degree of acquisition of **textual** information (for the Faculty of Applied Mathematics and Control Processes). Variables which significantly influence the **low degree** of acquisition of information in the form of **text** for group BD were not revealed.

4. Discussion and Conclusions

The findings support the main hypothesis of the research: effective acquisition of information presented via different visual forms in e-learning depends on students' psychological characteristics. There were observed are certain differences in students' characteristics (Table 5).

Table 5. Students' psychological characteristics influencing the high degree of acquisition of information presented in different forms

Faculty of Applied Mathematics and Control Processes				
students' psychological characteristics	Students' way of information processing (thinking styles)	Students' learning motivation, preference of certain methods and conditions of learning	Metacognitions, ability to self-organization, and preference of certain conditions of learning	students' psychological characteristics
	TEXT	CHARTS	COMICS	
students' psychological characteristics	Cognitions and preference of certain conditions of learning	Students' way of information processing (thinking styles), self-organization, predicted level of performance (self-assessment of achievements), and metacognitions	Students' ability to self-organization, the way of information processing, self-assessment of achievements, learning motivation, preference of certain methods and conditions of learning	students' psychological characteristics
Faculty of Biology				

It is remarkable that effective acquisition of information in the form of comics is determined by a greater number of students' psychological characteristics. This may be due to the complex structure of this kind of form of visual information – the combination of illustrations and text. On the other hand, the smaller number of students' psychological features have impact on assimilation of textual information, the cause being the teacher's more frequent use of multimedia presentations in the form of text in class. As a consequence of the above, the students have the experience of working with it. At the Faculty of Applied Mathematics and Control Processes students' acquisition of information in the form of charts depends on external and internal factors (motivation, methods and conditions of learning) but for students at the Faculty of Biology personal features had a greater impact on their assimilation of visual information.

Previous studies revealed that using images in PowerPoint presentations enhanced learners' comprehension (Chun & Plass, 1996; Mayer & Moreno, 2003; Seghayer, 2001). However, it does not mean that textual information or charts are ineffective and should be excluded from the teaching and learning process. There is correspondence between students' psychological characteristics and the forms of visual information, and we can not claim that only illustrations (comics) work more effectively for all learners. One of the further directions of research might be to identify the specificity of acquisition of animated information, and its dependency on students' psychological features.

The results obtained can help teachers to create conditions for students' more effective absorption of visual information by taking into account the correspondence between their students' psychological characteristics and forms of multimedia presentations used in the classroom. Supporting of such correspondence requires from teachers to be more attentive to students' behavior and on the basis of their observation to make conclusions about which form of visual information it will be better for them to use.

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